# SCENE TRIAGE CRITERIA ASSOCIATED WITH FATAL CRASHES AND POTENTIAL FOR USE OF EVENT DATA RECORDER (EDR) DATA

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## ABSTRACT

Millions of cars on the road today have Event Data Recorders (EDRs). A small percentage of cars currently have EDR data downloaded, typically hours or days after a motor vehicle crash (MVC). However, real time use of EDR data at the crash scene has the potential to save lives by providing additional quantitative information to emergency medical services (EMS) personnel in order to enhance the decisions they make on how and where to transport seriously injured persons (scene triage).

This paper presents the results of a population-based statewide study of all individuals involved in a specific type of fatal level crash for an entire year. (This paper reports on a subset of crashes from a statewide study of *all* fatal crashes for one year.) Based on the data collected for each victim of the crash, triage criteria were recorded and then compared to the victim's actual type of transport, (ground ambulance vs. air medical), injury severity, outcome, and hospital type (e.g., community hospital or trauma center).

The triage criteria collected for these crashes, including "mechanism of injury" criteria, (e.g., speed of crash), were then compared to data possible to collect from EDRs to determine how often EDR data could potentially be used to complement and potentially enhance triage decision making. A key decision that must be made at the scene of a serious crash is whether or not the severity of the crash or injuries would warrant a request for air medical transport to a trauma center (instead of ground ambulance transport to a community hospital). For the study group 16% were transported to a trauma center by ground, 11% by air.

From the study results, the paper discusses how the statewide use of quantitative real time EDR data could potentially enhance current triage guidelines.

## INTRODUCTION

The medical literature shows trauma victims' outcomes are influenced by triage decisions made at the scene of the injury or crash.[1-4] Trauma victims' outcomes, (particularly for the most severely injured victims), have been shown to vary with use of different types of transport (e.g., ground vs. air medical ambulance) and different levels of hospitals (e.g., community hospitals vs. trauma centers).[5-14] In another paper related to this study by the authors, the outcomes of crash victims were found to vary by 2:1 depending on the crash victim's "pathway" through the medical system. [in publication process]

A number of large population-based state and federal crash data bases contain detailed information about various characteristics of crashes, however, the utilization of medical system resources by crash victims is not their focus and therefore, it is not generally documented at all or in detail.[15,16] In addition, these data bases do not attempt to collect any information about what triage criteria may have been used at the scene of a crash to decide how and where to transport a crash victim for emergency medical treatment.

In order to determine what triage criteria may be associated with the type of emergency transport or hospital care crash victims actually received, it is necessary to conduct special studies..[17-20]

This paper reports part of the results from a statewide study of all persons involved in fatal level crashes for one year in Massachusetts. This study provides a population-based "snapshot" of the physiological, anatomical, mechanism of injury and special conditions triage guidelines matched to crash victims. This is one in a series of papers and presentations that present findings from the overall study; two papers have been published to date. [21,22]

In addition, the paper identifies which of the mechanism of injury (MOI) triage criteria, (e.g., "high speed crash"), may be possible to translate into appropriate engineering terms, and capture from existing, (or future), EDRs. At the time of this study, Massachusetts had the lowest MVC death rate in the US (one half the US rate).[16] The Massachusetts' rate was also one of the lowest in the world. [27]

Real-time use of the crash information from EDRs at the scene has the potential to enhance the triage decisions made by EMS personnel and save lives. In theory, the quantitative information from the EDR, *in combination with assessments of vital signs, level of consciousness and anatomic injuries at the scene,* can assist the decision-making process regarding how, (by ground or air ambulance), and where, (community hospital or trauma center), to send crash victims for optimal care. The authors and their colleagues have made multiple presentations related to this topic to national EDR groups.[23-26]

## METHODS

This paper reports on a subset of a statewide, population-based study that tracked all victims (n=940) of fatal level crashes (n=392) through the medical system from the scene of a crash. Fatal crashes were defined as those that had at least one person die from crash-related injuries within 30 days of the crash.

This paper's study population includes the 729 victims of 338 crashes who were occupants of passenger cars, vans and light trucks because these are the types of passenger vehicles that currently have, or may have in the future, EDRs. Non-occupant crash victims, (i.e., pedestrians, cyclists, motorcyclists, etc.), were excluded from this study. Table 1 shows the relationship of the study population to the state data overall.

Tracking crash victims required linkage of multiple statewide data sources, including crash, air medical, inpatient hospital and vital statistics.[16,28-31] Statewide ground ambulance, emergency department or trauma registry data bases did not exist at the time of the study. Paper records were collected and reviewed, including police and reconstruction reports, ground ambulance runs, and media reports.

All available documentation (electronic and paper) was reviewed to match each of the seriously or fatally injured crash victims involved in the 338 crashes to the appropriate triage criterion included in an air medical transport triage guideline developed by the state of Massachusetts and/or the trauma center triage guidelines developed by the American College of Surgeons (ACS).

The Massachusetts Department of Public Health (MDPH) and statewide Helicopter Utilization Review Committee (HURC) adopted recommended Air Medical Triage Guidelines in 1997. We retrospectively applied these guidelines to 1996 crash victims to try to identify patients who may have qualified for air medical transport from the scene of a crash. A copy of the MDPH air medical triage Guideline is included in a previous paper.[21] All references in this paper to air medical transport mean helicopter emergency medical services (HEMS), rather than fixed wing.

**Table 1 Massachusetts Motor Vehicle Crashes, CY 1996**

| Group | Population | Number of Crashes | Number of Persons |
|---|---|---|---|
| I. | Operator & Police Reported Crashes, All Injury Levels | 187,963 | 217,373 |
| II. | Police Reported Crashes, All Injury Levels | 106,359 | 126,547 |
| III. | Police Reported Crashes, Maximum of Serious Injury | 3,286 | 3,852 |
| IV. | Police Reported Crashes, Maximum of Fatal Injury* | 392 | 940 |
| V | Police Reported Crashes, Maximum of Fatal Injury* for Occupants of Passenger Cars, Vans & Light Trucks | 272 | 729 |

Notes *Died within 30 days of crash

The ACS developed and published a Field Triage Decision Scheme that is used to help identify patients who may be severely injured enough to require transport to a trauma center. [32]

Both the HURC and ACS guidelines have multiple sections with individual components in each section. These sections and components are described later. In this paper we have shown each of the components separately. Although some of the triage components are designed by MDPH or ACS to be used in combination, the fact that a crash victim met at least one triage criteria component indicates that they may have potentially qualified for a high level of emergency care.

All references in this paper to trauma centers mean American College of Surgeons (ACS) Level I trauma centers. At the time of this study, Massachusetts did not have a statewide trauma system nor did it have any ACS Level II or Level III trauma centers.

In a note accompanying its triage guidelines, the ACS acknowledges that systems of medical triage are inherently imperfect in classifying injured patients and can result in both over-triage (minimally injured patients taken to trauma centers) and under-triage (severely injured patients taken to non-trauma centers). [32] The ACS states: "In most systems, an under-triage rate of 5-10 percent is considered unavoidable and is associated with an over-triage rate of 30-50 percent.

An over-triage rate of up to 50% may be required to maintain a minimum level of under-triage in a community." This was included in the 1993 revision of the ACS book "Resources for Optimal Care of the Injured Patient, (the version in effect at the time of the study), and repeated in the 1999 version, which is still in effect.[32,33]

Although over-triage rates in the range of 30-50% sound large, because they are being applied to the top of the injury pyramid, they result in relatively small numbers to distribute over a statewide trauma system over a year. ACS points out: "It is estimated that because of the small number of patients who really need to be in trauma centers, the impact of patient flow on an individual institution will be minimal, should this degree of over-triage exist." [32]

The seriously or fatally injured crash victims were matched with all applicable triage guideline components. By tracking the pathway of each person through the state's medical system, their transport type and destination hospital were known. From this information it was possible to compare their actual utilization of air medical or trauma center services to the guideline criteria. It was also possible to calculate what numbers of patients would have represented a 30-50% over-triage rate, as noted by the ACS (as a reasonable system-wide goal).

The mechanism of injury (MOI) triage criteria components, for example, "high speed crash", that are included in the triage guidelines were compared to the data that is currently (or potentially) possible to collect from EDRs. This was done to determine if EDR data, collected at the scene of the crash in real time, could provide additional objective, quantitative data that might enhance triage decision making. We also examine the population of study victims that might have potentially benefitted from the EDR data.

## RESULTS

### Population Characteristics

The injury level distribution of the study population is shown in Table 2. Two hundred and ninety-six or 41% of the crash victims were either uninjured or sustained minor injuries (including a small number of unknowns). Only eight of these lower-severity patients were found to meet any of the triage criteria,

**Table 2 Study Population: Persons Involved in Fatal Level n = 272 Crashes**

| Injury Level | Persons Number | Percent |
|---|---|---|
| Fatal injury, Dead at Scene | 109 | 15% |
| Fatal Injury, Transported from Scene | 182 | 25% |
| Serious Injury (Incapacitating) | 142 | 19% |
| **Subtotal, Serious & Fatally Injured*** | **433** | **59%** |
| Non-incapacitating injury | 97 | 13% |
| Possible injury | 54 | 7% |
| No injury | 137 | 19% |
| Severity unknown, or unknown if injured | 8 | 1% |
| Subtotal for Less than Seriously Injured | 296 | 41% |
| **Grand Total** | **729** | **100%** |

**Notes**
*For the Serious & Fatal Group, 364 (84%) died or became inpat
All persons not dead at the scene were transported by EMS
Totals may not add to 100% due to rounding

or were actually transported to trauma centers. From the data linkage results, none were subsequently admitted as inpatients or died. The remainder of the results therefore pertain to the Serious and Fatally injured group shown in the Table.

The Serious and Fatal Group consists of 272 crashes and 433 victims who were either seriously or fatally injured and were considered to be likely candidates for either air medical transport and/or trauma center care. As noted on the table, a high percentage of these crash victims, (84%), subsequently died or were admitted as inpatients. This group contains all occupants of qualifying vehicles that could possibly be saved in trafficway reported crashes Statewide for the study year.

**Table 3 Crash Types and Principal Impacts For Serious and Fatally Injured Persons**

| Multiple Vehicle Crash Type | Crashes | | People | |
|---|---|---|---|---|
| Head On | 55 | 20% | 118 | 27% |
| Angle | 43 | 16% | 62 | 14% |
| Sideswipe | 2 | 1% | 4 | 1% |
| Rear End | 12 | 4% | 17 | 4% |
| Unknown | 1 | 0% | 2 | 0% |
| Subtotal | 113 | 42% | 203 | 47% |
| **Single Vehicle Principal Impact** | **Crashes** | | **People** | |
| Frontal | 99 | 36% | 131 | 30% |
| Right Side | 15 | 6% | 25 | 6% |
| Left Side | 15 | 6% | 19 | 4% |
| Rear | 2 | 1% | 2 | 0% |
| Undercarriage | 4 | 1% | 4 | 1% |
| Unknown | 8 | 3% | 23 | 5% |
| No Impact | 16 | 6% | 26 | 6% |
| Subtotal | 159 | 58% | 230 | 53% |
| **Total** | **272** | **100%** | **433** | **100%** |

Note: Totals may not add to 100% due to rounding

Several previous (unpublished) studies by the authors for the State of Massachusetts Governor's Highway Safety Bureau have shown that the use of the rating "serious injury" by the police (for victims of non-fatal, as well as, fatal crashes) was accurately associated with transport to a hospital for care. (As is the case in this study as well.) However, there is variation in how police rate injuries throughout the country and the Massachusetts situation may not be extensible to other states.

**Type of Crashes** (n= 272)

Table 3 shows the crash aspects and types for the 272 crashes organized by those involving multiple or single vehicles. The majority (58%) of crashes involve one vehicle and an average of 1.4 people per crash.

Multiple vehicle head on (20%) and single vehicle frontal (36%) crashes account for the majority of crashes 56%. The next largest percentage (16%) is multiple vehicle angle contacts and (12%) for single vehicle side impact crashes.

**Restraint Use and Air Bag Deployment** (n=433 crash victims)

Due to limitations in data entry to its electronic crash file, the state was unable to accurately record belt use and air bag deployment information in its statewide electronic files for 1996. However, the authors were able to review paper documents, and record this information for the 433 crash victims in the study. Table 4 shows that the percentages of unknown/unrecorded values for seat belt use and air bag deployment (at the occupant's seat position) were 29% and 63%, respectively.

**Triage Criteria Available and Met by Seriously and Fatally Injured Crash Victims** (n=433)

The specific triage criteria used by EMS personnel for each of the 433 persons is not known. Documentation of any type of EMS "triage checklist" was not submitted to the MDPH. However, as a proxy for what information, (at a minimum), may have been possible to use to support the scene triage decision, all of the electronic and paper data for each crash victim was reviewed and matched to the MDPH air medical and ACS trauma center trauma triage guidelines. This approach provided an overview of the information that was available from the existing data sets to support the triage decisions.

Table 5 shows a brief description of each triage criteria component and how often it was judged to have been "met", "not met" or "unknown" for each person. It is important to note that each seriously or fatally injured crash victim could have met zero, one or multiple triage criteria. The triage criteria are organized into sections: Operating Condition (in this case, multiple casualties), Mechanism of Injury (MOI), Physiological measures (first set of vital signs), Anatomic injury measures (not a focus of this study) and Other (age, pre-existing medical condition). "Non-triage criteria" refers to the victims who suffered traumatic cardiac arrest and therefore had a low chance of either surviving transport or reaching a trauma center. Some guidelines recommend these individuals not be transported by air.

**Table 4 Belt Use and Air Bag Deployment For Serious and Fatally Injured Persons** n=433

| | Belt Restraints Used | | Air Bag Deployed at Occupant's Seat Position | |
|---|---|---|---|---|
| **Yes** | 76 | 18% | 50 | 12% |
| **No** | 233 | 54% | 109 | 25% |
| **Unknown** | 48 | 11% | 5 | 1% |
| **Not Recorded** | 76 | 18% | 269 | 62% |
| Total | 433 | 100% | 433 | 100% |

Note: Totals may not add to 100% due to rounding

Results for the Anatomic Measures group are not shown in Table 5 because they were very limited. The source of the anatomic injury descriptions generally was the text notes included on the police reports (the vast majority of victims did not have ambulance patient care reports available). Although more information about anatomic injuries was available for the subset of crash victims who were admitted as inpatients, (from their hospital discharge diagnoses), this level of detail would not necessarily have been evident at the scene (prior to hospital diagnostic tests results being available). However, none of the crash victims had an anatomic measure as their only triage criterion; in the few situations where they were documented by the police, other criteria had already been met. Therefore, the overall results are not impacted by the absence of the anatomic components for the study group.

Some triage criteria were interpreted both specifically and broadly, for example, when "high speed crash", (ACS defines this as >40 mph), was judged to be "met", it was a combination of the police at the scene, or police crash reconstructionists documenting a crash speed estimated at >40 mph. However, if no other detail was available, and the police described the fatal crash as "high speed" this was accepted as having "met" criteria, as well.

The most important findings about the 433 seriously and fatally injured crash victims from Table 5 are:

-nearly all, 96%, met at least 1 triage criteria (including 4% of crash victims who suffered traumatic cardiac arrest) - despite limitations in the available data. Given the high percentage, 84%, of this group who either died or were admitted as inpatients, the prediction that nearly the entire group met triage seems reasonable.

- a small proportion, 4%, did not appear to meet any of the triage criteria

- physiological measures were unknown or not available for 74% - these are important measures, but often were not available for this study. However, it is important to note that in the cases when these variables were documented, the crash victim met the triage criteria. In other words, for the subset of these victims who had physiological data available, all of them met the triage guidelines and they all would have been likely to qualify for at least trauma center care, (and possibly air medical, as well, depending on time/distance issues), based on this information alone. This finding is consistent with prior studies.[17,18]

**Table 5 Triage Guideline Criteria: Percentage of Group Meeting Criteria n=433**

| Group | Met | Not Met | Unknown |
|---|---|---|---|
| **OPERATING CONDITION** | | | |
| **Multiple Casualties** | 29% | 71% | 0% |
| 3 or more Seriously / Fatally Injured in Crash | | | |
| **MECHANISM OF INJURY** | | | |
| **Vehicle Level - Apply to all persons in a specific vehicle** | | | |
| Major Auto deformity e.g. >20" ACS | 88% | 11% | 1% |
| High speed crash e.g. >40 mph ACS | 47% | 50% | 4% |
| Intrusion into passenger compartment e.g. >12" ACS | 32% | 63% | 6% |
| Death in same passenger compartment. | 21% | 79% | 0% |
| Rollover ACS | 20% | 79% | 0% |
| **Person Level - Factors that apply to individuals** | | | |
| Occupant ejected from vehicle. | 17% | 82% | 1% |
| Prolonged extrication ACS | 6% | 92% | 2% |
| pinned or crushed by vehicle | 5% | 95% | 0% |
| >12" Intrusion at Occupants position | 5% | 94% | 1% |
| Trapped in burning vehicle | 2% | 98% | 1% |
| Steering wheel deformed | 2% | 98% | 0% |
| **PHYSIOLOGICAL MEASURES - First Set of Vital Signs** | | | |
| Blood Pressure <90 | | | |
| GCS <=12 | 25% | <1% | 74% |
| Respiration <10 or >30 | | | |
| **ANATOMIC MEASURES - Evident at Scene** | | | |
| See Text | | | |
| **OTHER** | | | |
| Age greater than 55 or less than 10. | 27% | 73% | 0% |
| Significant Pre-Existing Medical Condition | 6% | - | - |
| For those reaching inpatient status only | | | |
| **NON TRIAGE CRITERIA - Evident at Scene** | | | |
| Cardiac arrest subsequent to blunt trauma | 4% | | |
| **TOTAL PERSONS MEETINGS TRIAGE** | | | |
| Met at Least 1 Triage Criteria | 92% | | |
| Met at Least 1 Criteria, but had blunt trauma cardiac arrest | 4% | | |
| Persons not meeting any of the Triage Criteria | 4% | | |

Note: Totals may not add to 100% due to rounding

The top six triage criteria most often met by the seriously and fatally injured crash victims were:

| | |
|---|---|
| - Major auto deformity | 88% |
| - High speed crash | 47% |
| - Intrusion into passenger compartment (Any location) | 32% |
| - Age >55 or <10 years | 27% |
| - Physiological (BP, GCS, respiration) | 25% |
| - Death in same passenger compartment | 21% |

The top six mechanism of injury (MOI) triage criteria most often met were:

| | |
|---|---|
| - Major auto deformity | 88% |
| - High speed crash | 47% |
| - Intrusion into passenger compartment (Any location) | 32% |
| - Death in same passenger compartment | 21% |
| - Rollover | 20% |
| - Ejection | 17% |

Although the Physiologic measures have the greatest predictive power, the MOI measures have low unknown rates - which makes the idea of using them - via EDR data - to enhance triage attractive.

**Medical System Utilization by Seriously and Fatally Injured Crash Victims** (n=433)

Table 6 shows the aggregate medical system utilization for the 433 crash victims. One hundred and six (24%) died at the scene and did not receive further medical transport or intervention. Forty-eight (11%) were taken directly from the scene by air medical helicopters to Level I trauma centers. Seventy (16%) were taken directly from the scene by ground ambulances to Level I trauma centers. Therefore, a total of 118 (27%) were taken from the scene to Level I trauma centers, via either ground or air medical transports.

Two hundred and nine crash victims were not taken to a trauma center from the scene. Of this group, 129 subsequently died.

**Potential Over- or Under-Triage and Population that May Benefit from Scene EDR Data**

Keeping in mind that the State did not have a statewide triage guideline operating in the study year (it's air medical guideline is being retrospectively applied), 96% of the serious and fatal group are candidates for transport to a trauma center, while 27% were actually transported to a trauma center. The difference of 69% - 315 persons- is the group whose transport might be influenced by additional quantitative data.

**Table 6 Transports to Trauma Centers**

| Location | Persons Number | Persons Percent |
|---|---|---|
| **Dead at Scene** | 106 | 24% |
| **Scene Ground to Trauma Center*** | 70 | 16% |
| **Air Medical to Trauma Center*** | 48 | 11% |
| **Other** | 209 | 48% |
| **Total** | **433** | **100%** |

Notes: *Includes dead on arrival transports
Other group includes 129 deaths
Totals may not add to 100% due to rounding

One might expect to see some of the 30-50% ACS over triage in transports from the 296 persons with injury severities in Table 2 lower than serious. A 30% over triage would be 130 persons. However, as mentioned previously, eight of these 296 lesser injury level victims were transported to a trauma center. There is no indication of any over triage.

Of the persons who were not transported to a trauma center, 129 died. This is the group where a potential exists to save lives; and additional objective information might make a difference. For Massachusetts in the study year, 129 deaths was 31% of all trafficway deaths reported; so it is a substantial fraction.

If EDR data contributed to decisions that resulted in the survival of an additional 20-40 crash victims from this group, that would have the effect of further reducing the (already low) death rate in Massachusetts by 5-10%.

## Triage Criteria vs. Possible Output from EDRs

Other than "death in same passenger compartment" many of the MOIs shown in Table 5 can be "translated" into engineering terms that represent variables that could be collected by EDRs.

Table 7 provides examples of EDR variables that might be collected to obtain the key mechanism of injury information in a more objective and quantitative manner.

Key variables used by crash researchers to estimate the severity of a crash and the risk of serious injury include delta V, crash pulse, and principal direction of force. In the past, crash investigators have calculated this information as part of crash reconstructions conducted some period of time (e.g., hours or days) after the crash. EMS personnel currently are only able to "guess" crash speeds and vehicle crush or intrusion as rough proxies for crash severity. With scene access to the vehicle "black box" or EDR data, more objective crash severity information could be used to estimate the risk of serious injury by EMS personnel. Of course, the engineering data downloaded from the EDRs would have to be converted into a format that is easy for EMS personnel to understand, interpret and utilize quickly. A rapid, non-contact download method with passive power would be desirable for this purpose. Similar technology is used in transit system faire cards and car electronic key systems.

**Table 7.**
**Examples of Use of EDR Data for Triage**

| **Mechanism of Injury** | **Current source** | **EDR source** |
|---|---|---|
| High speed | "guess-estimate" | delta V, crash pulse |
| Crush/intrusion | "guess-estimate" | delta V, crash pulse |
| Rollover | observation | rollover sensor |
| Ejection | observation | seat sensors |
| Multiple casualties | observation | seat sensors |
| Airbag deploy | observation | deploy trigger |
| Belt use | observation | belt sensor |

Although some of the variables in Table 7 may seem inherently obvious, EMS personnel arrive at some scenes to find victims lying on the ground who either were removed, (on their own or by bystanders) or ejected, from the vehicle. Therefore, their seating position and restraint use would not be possible to directly observe, either. In addition, when EMS personnel arrive at the scene, they may find vehicles at rest in a normal upright position that actually had rolled 360 degrees (or multiples of 320 degrees) during the crash event.

As noted in Table 3, the majority of crashes (58%) involved one vehicle and averaged 1.4 people per crash. This suggests that it generally would not be difficult for EMS personnel to "match" the right victim to the right vehicle and its associated EDR data, even if the victims are discovered outside the vehicle(s). However, for some victims of serious or fatal crashes, prolonged extrication is required to free them from the vehicles - in this study, it was specifically mentioned for 6% of the victims (However, this percentage may be low, because it is not clear if any extrication information would have been recorded for the trapped victims who are dead at the scene).

Risk of injury algorithms could be developed for simple use by EMS personnel at the scene that relied on EDR information for each crash victim, such as, severity of crash variables (crash pulse, delta V, etc.), as well as, seating position, restraint use (seat belts, air bags, etc.), and ejection/rollovers flags, etc. These algorithms could be refined over time as more "real world" crash injury data and outcomes became available. The algorithms would be designed to be used at the scene by EMS personnel to complement their patient assessments of physiological status and anatomic injury, as well as, other important factors.

As noted earlier, restraint use and air bag deployment were often unknown/unrecorded (29% and 63%, respectively), for the seriously and fatally injured crash victims. EDR data could provide an objective source of restraint use and air bag deployment for all occupants, by seating position. Clinicians, and injury severity algorithms, factor in restraint and air bag deployment information when assessing or predicting the risk of particular types of life-threatening injuries.

As noted earlier, 20% of crash victims were occupants of vehicles that rolled over - an EDR sensor potentially could capture this information. 17% of crash victims were ejected; EDR data potentially could help identify (or confirm) this mechanism of injury, as well.

Future studies could also determine if, under certain circumstances in severe crashes, using EDR data from one car in a two vehicle collision is reasonable to support any key triage decisions for injured persons in the other car that did not have an EDR. This would be a potential issue until 100% of the fleet actually had EDRs.

**Review of Crashes with Scene Deaths to Identify Possible Delays in EMS Notification** (n=99)

To address the question of whether any of the scene deaths possibly may have been related to delays in EMS notification, detailed information on all 99 crashes with scene deaths was reviewed. The scene deaths are those most likely to benefit from technology such as Automatic Crash Notification (ACN). The study scene crashes included, for example, unwitnessed, late night crashes involving a single vehicle running off the road with one or two occupants who may have been too severely injured or isolated to summon help. Table 8 shows 15 crashes where scene deaths possibly may have been related to delays in EMS notification. This represents 4% of the statewide 392 fatal crashes.

This may indicate the potential extent of benefits related to automatic crash notification (ACN). A number of papers discuss the potential benefits of ACN, but the initial focus of ACN generally is on crashes occurring in remote areas that are less likely to be witnessed. [34,35] However, it was not part of this study to determine if a vehicle's ACN system, (e.g., antenna or other components), could have survived and functioned after such severe crashes or if cell phone coverage existed in the areas of the state where the ACN may have been needed.

Also, this study did not try to ascertain how often injured crash victims may have been conscious, and therefore, capable of using a cell phone to summon EMS vs. rely on an ACN system for assistance.

An additional 23 crashes with possible delays in EMS notification were associated with catastrophic injuries likely to cause instantaneous death, so outcomes would not have been changed by earlier EMS notification.

The remaining 61 crashes with deaths at the scene did not include documentation suggesting delays in EMS notification.

**DISCUSSION**

Based on the available data, many more people appear to qualify for transport to a trauma center than received it. There is no evidence of a pattern of over-triage of crash victims to either air medical transport or trauma centers for the study population.

**Table 8 Dead at Scene Crashes with Possible Delayed Disc**
**Seriously & Fatally Injured Person**

| Group | Crashes | | Persons | |
|---|---|---|---|---|
| **Possible Delayed Discovery, may have affected scene death** | 15 | 6% | 25 | 6% |
| **Possible Delayed Discovery, but catastrophic injury*** | 23 | 8% | 37 | 9% |
| **Dead at Scene Crash, No Apparent Delay in EMS notification** | 61 | 22% | 44 | 10% |
| **All Other Crashes no Deaths at Scene** | 173 | 64% | 327 | 76% |
| **Total** | **272** | **100%** | **433** | **100%** |

Notes *Reasons include killed instantly due to massive trauma;
Trapped in, or under, vehicle which burst into flames,
Airbag did not deploy (no notification event)
Totals may not add to 100% due to rounding

The data indicates that physiological data is important for triage, and that its accurate collection should be the first priority. Nearly 100% of the victims meeting physiological criteria were transported to trauma centers. However, the elevated unknown rate for this information makes the use of MOI data from EDRs look attractive as a possible complement.

The potential appears to exist to use downloaded data from the current generation EDRs at the scene of serious/fatal crashes, *in combination with the patient assessment,* to help EMS personnel triage crash victims. Discussion of how this potentially could be accomplished and technical issues that would need to be addressed for scene use are included in other documents. [23,24,25,26]

Another advantage to EDR data is that it does not require the EMS personnel to "write down" additional data, they would simply download the data and convert it into an appropriate format. Therefore, data completeness on a statewide basis, may be easier to achieve, at least for the fatal level crashes. NHTSA has initiated some efforts to try to collect EDR data for its FARS, SCI and CIREN data bases (but not for real time medical use, at the scene of crashes, on a statewide basis).[36,37].

Additional studies are needed to determine if existing EDR data, if downloaded at the scene of crashes, and coupled with patient assessments, could potentially provide additional objective information about the severity of the crash and occupants' risk of life-threatening injury that would influence triage decisions.

Consistent with this study, others have concluded that physiologic and/or anatomic trauma triage criteria are more powerful predictors of air medical transport and increased hospital resource utilization and/or injury severity than mechanism of injury alone or in combination with these measures [12,17-20]

Based on the literature and this study's findings, it appears it would be extremely difficult to convince a state like Massachusetts to deploy high level EMS services based on mechanism of injury EDR data alone, at this time.

## CONCLUSIONS

During the year studied, Massachusetts had the lowest MVC fatality rate in the US.

No "gold standard" exists for the appropriate percentages of victims of fatal level crashes that should receive air medical transport and/or trauma center treatment from the scene of a crash. However, the Massachusetts data showed for a population of the most seriously and fatally injured crash victims, (occupants of passenger cars, vans and light trucks), that 96% retrospectively appear to have met triage criteria, but 11% and 16%, respectively, received air and ground transport from the scene to a trauma center.

The study population contained all the victims whose lives theoretically are possible to save (from the qualifying vehicles) for the study year. Of the 209 persons not transported to a trauma center, 129 expired. This comprised 31% of the statewide trafficway deaths for the study year. On that basis, a potential to save lives by enhancing triage appears to exist. The study results support the rationale for the medical and engineering community to work together to add a "black box" for EDR data to trauma triage decision trees.

The study points out opportunities to use EDR data to enhance triage in two important, but different ways. First, possible "real time medical use" at the scene of a crash, in combination with patient assessments, to help support triage decisions, and second, for statewide evaluations of EMS system response to fatal level crashes in order to enhance response over time.

The study population consists of only very serious crashes. Consequently, it cannot predict the "false positives" that might occur using EDR data to enhance triage in lower severity crashes. This requires further study.

The findings of this study are based on a census of only the most severe crashes and are not extensible to all crashes in the state. In addition, the findings for Massachusetts are not generally extensible to the US overall. Comparative studies of similar data from other states, provinces or countries would be very useful.

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